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EARTHQUAKES IN BRAZIL

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Earthquakes are so rare in Brazil that their very rarity is a matter of interest to geologists and seismologists. In order to give an idea of the low seismicity of that country and to facilitate the collection and preservation of data in the future I have brought together in this paper all the information it has been possible to gather from a considerable acquaintance with the literature of Brazilian geology.

In January, 1909, Dr. M. A. R. Lisboa of Petropolis, a distinguished Brazilian geologist, published in the *Jornal do Commercio* of Rio de Janeiro a résumé of Brazilian earthquakes that is the most complete list thus far printed. That paper, however, is not accessible to geologists and seismologists, and I have been able to make several additions to the list.¹

The table gives all the reported earthquakes in their chronological order, and one column shows the intensities by the Rossi-Foré scale as nearly as they can be judged from the accounts.

The papers cited include all the known publications regarding earthquakes in Brazil. There is one important article, however, bearing upon seismology in Brazil that has not been used in constructing the table, and that is a paper containing a list of earthquake shocks reported at sea off the northeast coast of Brazil by sailing masters. That article is entitled "Note sur l'existence probable d'un volcan sou-marin situé par environ 0° 20' de latitude sud, et 22° de longitude ouest," par P. Daussy, *Comptes Rendus*, VI, 512-18 (Paris, 1838).

In his "Tremblements de Terre," *Géographie Séismologique*, M. Montessus de Ballore gives a chart of the region at p. 168.

1. *Manoel Ayres de Casal*.—Corografia Brazilica, ou relação historico-geografica do Reino do Brazil, I, 261. Rio de Janeiro, 1817.

In his description of the province of Matto Grosso the author has this note on earthquakes: "On the 24th of September (1744) at noon, during clear weather, underground thunder was heard, and immediately the earth trembled, giving

¹ See reference No. 14 below.

several rockings that caused great alarm everywhere in Matto Grosso and Cuyabá.
 The earthquake that shook the Kingdom of Peru and destroyed the city

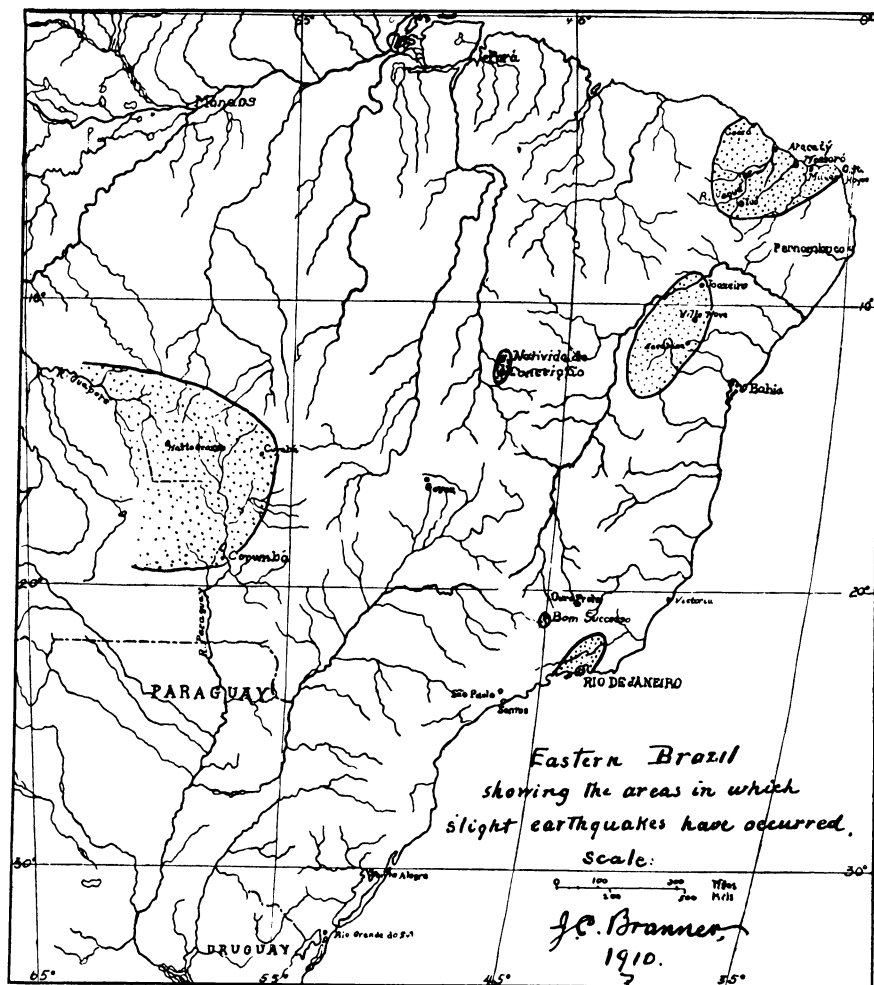
TABLE OF EARTHQUAKES REPORTED IN BRAZIL

Figures on the right refer to the authorities following the table

Year and Date	State	Locality	Intensity (Rossi-Forel)	Authority
1744, Sept. 24...	Matto Grosso	Cuyabá, etc.	VI	Cazal, 1
1746, Oct. 28...	Matto Grosso	Matto Grosso	V	Cazal, 1
1767 (9?), Aug. 1	Espirito Santo	.....	.....	Capanema, 2
1807, Aug. 8....	Ceará	Jaguaribe Valley	.....	Pompeo de Souza, 3
1810, May 31...	Ceará	Granja	.....	Pompeo de Souza, 3
1811, Oct. 28...	Pernambuco	Recife	VI	Dom Pedro, II, 4
1812 (13?).....	Rio Grande do Sul	Porto Alegre	.....	Capanema, 2
1824.....	Ceará	Jardim	VIII- IX?	Pompeo de Souza, 3
1824.....	Minas Geraes	Caximbú, etc.	VI	Massena, 5
1826.....	Goyaz	Natividade	IV-V	Gardner, 6
		Conceição		
1832, Sept. 18...	Matto Grosso	Príncipe da Beira	.....	Fonseca, 7
1834.....	Goyaz	Natividade	IV-V	Gardner, 6
		Conceição		
1846.....	Ceará	Granja	.....	Pompeo de Souza, 3
1852, Dec. 2....	Ceará	Aracaty	.....	Capanema, 2
1852.....	Ceará	Granja	.....	Pompeo de Souza, 3
1854, Jan. 10...	Rio Grande do Norte	Touros	.....	Capanema, 2
1855.....	Ceará	Granja	.....	Pompeo de Souza, 3
1860, Oct. 1....	Matto Grosso	.....	.....	Fonseca, 7
1861, June.....	Rio de Janeiro	Paraty, etc.	IV-V	Massena, 5
1867, Several....	Minas Geraes	Jaguára	IV	Burton, 8
1876, June 26...	Matto Grosso	N. of Corumbá	IV	Fonseca, 7
1886, May 9....	Rio de Janeiro	Petropolis, Rio S. Paulo, Minas	V	Dom Pedro II, 9 Cruls, 10
1901, April 4..	Minas Geraes	Bom Successo	IV	Silveira, 4
1901, April 5..				
1901, July 1..				
1901, Sept. 4..				
1905, July 18...	Bahia	Bomfim to Joazeiro	IV-V	Silva, 12 Branner, 14
		Miranda		
1906, Nov.....	Matto Grosso	Coimbra	IV-V	Lisboa, 13
		Corumbá, etc.		

of Lima in October, 1746, was clearly felt here; but it only frightened a few of the inhabitants."

It should be noted that Dr. Fonseca mentions an earthquake in Matto Grosso on September 24, 1749. It seems probable that there is some confusion in regard to the year. See reference 7 below.



2. *G. S. de Capanema*.—Quaes as tradições, ou vestígios geológicos que nos levam a certeza de ter havido terremotes no Brazil. *Revista do Instituto Historico*, XXII, 135-59, Rio de Janeiro, 1859. (Read November 24, 1854.)

Barao de Capanema wrote to the presidents of all the Brazilian provinces for information regarding earthquakes; after three years, no replies having been received, the request was renewed by the Instituto Historico e Geographico, and to these later inquiries six of the presidents replied, but apparently most of them gave negative results. The paper contains reference to some phenomena that may or may not indicate earthquakes. Capanema's list includes the two mentioned by Ayres de Casal in Matto Grosso, and some of those given later and a little more at length by Thomaz Pompeo de Souza for Ceará. He adds one for Espirito Santo, and one for Rio Grande do Sul. The paper is occupied chiefly with a discussion of earthquakes in general.

3. *Thomaz Pompeo de Souza Brasil*.—Ensaio estatístico da provincia do Ceará, I, 51 (Ceará), 1863. Under the head of "earthquakes" the author states that a few slight shocks have been felt in the valley of the Rio Jaguaribe and at Granja, north of Fortaleza. The important footnote is here given at length:

"The following are the earthquakes of which I have been informed: On August 8, 1807, throughout the entire valley of the Jaguaribe extending northward to Fortaleza (180 kilometers), southward to Icó (300 kilometers), and eastward to Mossoró and the Serra do Martins in the province of Rio Grande do Norte.

"On May 31, 1810, at Granja, and again in the years 1846, 1852, and 1855.

"In 1824 the earth opened making a wide crack from the base of the Serra de S. Pedro to Jardim, a distance of 5 leagues, with a width of about one palm and of unknown depth.

"On December 2, 1852, at Aracaty."

4. *Dom Pedro d'Alcantara*.—Documentos relativos ao tremor de terra havido em Pernambuco em 1811. Revista do Instituto Historico e Geographico, XXIII, 401-6. Rio de Janeiro, 1860.

The date and intensity of an earthquake felt at Pernambuco October 28, 1811, are fixed by three letters written by observers in reply to inquiries made by the Emperor Dom Pedro II. One observer states that the people were filled with terror; another reports that the shock was so violent that things were nearly thrown from tables, and a fountain erected in the patio of one of the churches was overthrown. This suggests an intensity of about VI of the Rossi-Forel scale.

5. *José Franklin da Silva Massena*.—Investigações scientificas para o progresso da geologia mineira. Revista do Instituto Historico e Geographico, XLVII, 249-82. Rio de Janeiro, 1884.

This is a long article devoted to geology, but at p. 281 the following mention is made of two earthquakes:

"The earthquake of Parati in June, 1861, was quick and oscillating, and was felt in Areias and along the coast, and even at Itajubá.

"The earthquake of 1824 extended from Caximbú to Picú and was felt in the open country. Though the movements were not sufficient to kill persons or animals or to crack the earth, buildings suffered and men felt a dull, quick, rocking shock."

6. *George Gardner*, the English botanist who traveled through Goyaz in 1840, has the following in his *Travels in the Interior of Brazil*, etc., London (1846), 350:

"Within the last twenty years, two slight earthquakes have been felt both at Natividade and Conceição; the first occurred in the year 1826, and the other in 1834; the movement of the earth was very perceptibly felt in both places, although they were each of short duration. These were the only places in Brazil where I could learn such phenomena had been observed."

7. *João Severiano da Fonseca*.—*Viagem ao redor do Brasil* (1875-78), I, 198. Rio de Janeiro, 1880.

This writer, in speaking of the province of Matto Grosso, has the following upon earthquakes:

"The annals of the senate of the chambers of Cuyabá mention an earthquake on September 24, 1749, preceded by a loud noise like subterranean thunder.

"On one of the walls of the prison at fort Príncipe da Beira on the Guaporé I found the following inscription made there by a prisoner with the point of a style. 'On the 18th of September at two o'clock in the afternoon the earth trembled, 1832.'

"Another earthquake is registered on October 1, 1860.

"On June 26, 1876, at about half-past nine at night, while at the fazenda Cambára near the margin of the Rio Paraguay with the other members of the boundary commission, we felt a sharp shock as we lay in our hammocks and beds, and at the same time there was a rattling of the tiles of the roof as if caused by hail, the whole lasting only a few seconds."

The last-mentioned place is between the city of Corumbá and the mouth of Rio S. Lourenço.

8. *Richard F. Burton*.—*The Highlands of the (sic) Brazil*, II, 30. London, 1869.

The author, when near Jaguára in Minas Geraes, made this note in August, 1867: "Sr. Leite, an intelligent store-keeper at the Quinta, which is about half a mile from the River, assured me that the ground had lately been subject to shocks, which were most frequent about full moon."

9. *Dom Pedro d'Alcantara*.—Tremblement de terre survenu au Brésil le 9 mai 1886. *Comptes Rendus*, CII, 1351-52. Paris, 1886. Also in *Nature*, XXXIV, 1887-88. London, 1886.

This is a letter from the Emperor Dom Pedro II to M Daubrée, reporting a shock felt at Petropolis at 3:20 P.M. on the date mentioned. He notes the rattling of windows, and that the shock continued about four seconds. He reports the general area over which the shock was felt; it amounts to about 25,000 square kilometers.

10. *M. Cruls*.—Tremblement de terre au Brésil. *Comptes Rendus*, CII, 1383-84. Paris, 1886.

The shock described by M. Cruls, late director of the astronomical observatory at Rio de Janeiro, is the same as that reported to the French Academy by Dom Pedro II. He says it occurred at Rio de Janeiro, May 9, 1886, between 3 and 3:30 P.M., that it lasted from a few seconds to a minute, and was felt in the provinces of Rio de Janeiro, São Paulo, and Minas over an area about 250 kilometers long by 110 kilometers wide, with its longer axis lying N. 60° E.

11. *Alvaro A. da Silveira*.—Os tremores de terra em Bom Successo, Minas Geraes, Bello Horizonte, 1906. Originally published in *Minas Geraes*, the official organ, at Bello Horizonte, November 1, 1901.

An earthquake occurred at Bom Successo in the southern part of the state of Minas Geraes on April 4, 1901. The governor of the state appointed Sr. Alvaro A. da Silveira to collect information in regard to it. His official report along with other articles that were published on the same subject are brought together in a brochure of 137 pages. The following are the matters of chief interest:

The first shock that was noticed occurred at 1 P.M., April 4, 1901; it was strong enough to rattle dishes, and was accompanied by a rumbling noise.

April 5 at 5 A.M. there was a similar shock.

Subterranean sounds continued to be heard during the months of April, May, and June.

July 1 at 11 P.M. there was a strong shock, and subterranean sounds continued to be heard through July and August. During the latter half of August no sounds were heard.

September 4 at 6 P.M. a sharp shock was felt, about like that of April 4, and people left their houses. During the rest of September and during the first half of October sounds like distant thunder were occasionally heard. Between the 9th and the 15th of October there was but one rather loud rumbling; the others were all small.

He repeats that there were barely four shocks in all; that they caused no damage whatever, even to houses whose walls might easily have been thrown down.

12. *Lourenço Pereira da Silva*.—O município do Bomfim. Bahia, 1906, p. 37.

This is a small book of 85 pages 12° describing the natural features of the municipality of Bomfim, formerly known as Villa Nova da Rainha, in the state of Bahia. At p. 37 he says: "It must be still remembered by everyone that an earthquake shock was felt in July, 1904, throughout the zone between Bomfim and Joazeiro. It consisted of a dull rumbling followed by a slight shaking of the earth causing the rattling of dishes and bottles on the shelves of stores, while in homes ornaments and even bird cages were thrown down."

13. *Arrojado Lisboa*.—Tremores de terra no Brasil. Jornal do Commercio. Rio de Janeiro, January 23 (?), 1909.

This is part of a long article on the general subject of earthquakes, ending with a section on earthquakes in Brazil. The copy kindly sent me by Dr. Lisboa is a clipping from the daily paper in which it was printed, and does not contain the date of its publication. The article itself is dated January 22, 1909. The author mentions most of the cases in the table given herewith, and adds information gathered by himself in the state of Matto Grosso in 1908.

He concludes that the following regions in Brazil are periodically affected by earthquakes:

1. Bom Successo district in Minas Geraes.
2. State of Rio de Janeiro.
3. Aracaty-Assú region in Ceará and Rio Grande de Norte.
4. The southern portion of Matto Grosso.

He mentions the seismograph in the observatory at Rio de Janeiro and urges the importance of the establishment of three additional stations under the direction of the astronomical observatory as follows: at Aracaty in Ceará or at Macão or Mossoró in Rio Grande do Norte; at Porto Murtinho, Corumbá, or Miranda, in Matto Grosso, and a third at Bom Successo in Minas Geraes.

14. *Notes by J. C. Branner*.—While traveling through the interior of the state of Bahia in 1907 I found that a slight earthquake had been felt over a considerable area in that region in the year 1905, and the following notes were gathered in regard to it:

There is uncertainty about the year. Some of the persons with whom I talked about it stated positively that it occurred July 18, 1905. Sr. Lourenço Pereira da Silva, quoted above, says it was in 1906, but he does not mention the day of the month.

It was felt by some people, but not by all, at and about the city of Bomfim, where window shutters and bottles on drugstore shelves rattled.

At fazenda Cambao, on the west side of the Salitre Valley, the shock occurred about 8 P.M. and was accompanied by a distant rumbling sound. A man lying in

a hammock reports that it felt as if someone were jerking the cords of his hammock. The iron stirrups of saddles hanging against a wall were rattled together.

At Moita on the fazenda Ingazeira, west side of the Salitre Valley, the shock occurred between 7 and 8 P.M. Hammocks swung, dishes and pans rattled. Similar disturbances were felt at Retiro on the upper part of Rio Ingazeira.

It was felt by many, but not by all, at the city of Morro do Chapeo. A priest lying in a hammock noted that it began to swing; in the shops the bottles on the shelves rattled against each other; a partly opened door slammed; a man leaning against the wall of a house felt it give way and thought it about to fall.

The limits of the area affected were not determined with any clearness. It was not felt at all at Alagoinhas or Aramary, but it was not ascertained certainly whether it was noticed at Serrinha or Queimadas. It has not been possible to find out whether it was felt north and west of the Rio S. Francisco. The outlines of the area affected are shown on the accompanying map as nearly as present knowledge permits.

The other two areas shown on the map are that about Rio de Janeiro, suggested by the data furnished by Dom Pedro II (reference 9), and the one suggested by the notes of Senator Pompeo de Souza (reference 3).

The Matto Grosso area is represented as extending westward indefinitely. It is so shown because it is assumed that the slight earthquakes that have been felt in that region originate in the Andean country to the west.

The following notes of negative value are not without interest:

A. *Collie*.—Geological Observations on the Neighbourhood of Rio de Janeiro. Capt. F. W. Beechey's Narrative of a Voyage to the Pacific and Behring Strait, London, 1831, II, 159.

This writer says: "Respecting earthquakes at Rio de Janeiro, I could get no further information than that they are rare."

Francis de Castelnau.—Expédition dans les parties centrales de l'Amérique du Sud. Histoire du voyage. Paris, 1850. I, 202.

This author suggests that certain steep-sided ravines near Barbacena may be due to earthquakes, but he makes no mention of earthquakes having been reported.

In Vol. II at p. 83 he says that earthquakes are quite unknown in the central parts of Brazil.

When it is remembered that Brazil occupies an area almost as large

as that of the United States, one must regard the list here given as noteworthy, and probably impossible for any other portion of the globe.

It is quite probable that, with the natural increase of population and the increased facilities for communication, the frequency of earthquakes will appear to increase somewhat in the future, but such an increase will be apparent rather than real.